KEY TOPICS IN ANESTHESIA

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NORTH AMERICAN EDITION

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Original edition published in the United Kingdom under the title of Key Topics in Anaesthesia. BIOS Scientific Publishers Limited, 1992.
This edition for sale in the United States and Canada only.

Printed in the United States of America
Composition by Mosby–Year Book
Printing/binding by R.R. Donnelley

Mosby–Year Book, Inc.
11830 Westline Industrial Drive
St. Louis, Missouri 63146

International Standard Book Number 0-8151-1908-9

95 96 97 98 99 / 9 8 7 6 5 4 3 2 1

PREFACE

North American Edition

I have revised this version of Key Topics in Anesthesia, from the original UK edition by Drs. Craft and Upton, to be consistent with North American anesthesiology practice. The authors' primary goals of providing a quick reference text to resident and practicing anesthesiologists for use in daily case management and as a study aid in preparation for the ABA written and oral examinations has been maintained. Topics on regional anesthesia and acute pain management have been added or expanded in an effort to include clinical information that has been emphasized on examinations and used more frequently in perioperative care. This book is not intended to be a comprehensive reference nor is it a technical manual for commonly performed clinical procedures. Suggested readings for a more complete discussion of the subject are provided at the end of each topic.

Douglas G. Martz

PREFACE

Common problems occur commonly. This is as true for postgraduate examinations as it is for clinical practice. The difficulty is that common clinical problems are not always the same as common examination problems. This impression developed during our own preparation for the postgraduate examinations in anaesthesia and has been reinforced by our efforts in helping others work towards their exams. Scrutiny of recent past papers and discussion with candidates reveals that certain topics occur far more frequently under conditions of examination than they do in clinical practice. This is not surprising. The examinations must be reproducible. They must set and maintain standards. Topics being examined must have clearly defined and widely agreed goals; not all clinical problems do.

This book aims to provide the reader with a framework of information about a number of key topics. It attempts by way of a common format to engender a problem oriented approach to clinical tasks which, when adopted, will be of use to the candidate considering questions in areas not discussed in the book. Other material which does not lend itself to this format is also included as we feel that it is central to the discussion of a number of clinical topics. A text such as this could never be comprehensive and this one does not set out to be so. Certain anaesthetic sub-specialities such as intensive care, pain management, and regional blocks are well described for revision purposes elsewhere. These areas have been afforded topics of general consideration but in-depth discussion has been deliberately omitted. The fields of pharmacology and physiology that make up the bulk of Part II of the examination for the Fellowship of the Royal College of Anaesthetists in the UK are also only considered in the context of their application. What remains is a core of topics collated to be of use to the anaesthetist working towards their professional examinations (Parts I and III of the UK FRCAnaes or equivalent) and as a general aid to all practising anaesthetists. Just as in the examination, a number of 'medical' topics are covered together with anaesthetic problems pertinent to modern clinical practice.

The reader is encouraged to fill out the information further both by referring to those topics of related interest and by consulting the references cited at the end of each topic. A short index is provided to help locate certain key areas within the book.

We are indebted to those colleagues who have read and corrected various topics, in particular Chris Nixon, and to Linda for her encouragement and knowledge of desktop publishing.

Timothy M.Craft
Paul M.Upton

ABBREVIATIONS

ACT	Activated clotting time
ADH	Antidiuretic hormone
ARDS	Adult respiratory distress syndrome
BMR	Basal metabolic rate
BP	Blood pressure
CBC	Complete blood count
CFM	Cerebral function monitor
CNS	Central nervous system
CPAP	Continuous positive airway pressure
CPR	Cardiopulmonary resuscitation
CSF	Cerebrospinal fluid
CVA	Cerebrovascular accident
CVP	Central venous pressure
CVS	Cardiovascular system
CXR	Chest X-ray
DIC	Disseminated intravascular coagulopathy
DVT	Deep venous thrombosis
ECG	Electrocardiogram
ECM	External cardiac massage
EEG	Electroencephalogram
FDP	Fibrin degradation products
FEV_1	Forced expired volume in 1 second
FRC	Functional residual capacity
FVC	Forced vital capacity
GFR	Glomerular filtration rate
ICP	Intracranial pressure
ICU	Intensive care unit
IHD	Ischemic heart disease
IOP	Intraocular pressure

IPPV	Intermittent positive pressure ventilation
ITU	Intensive therapy unit
LFT	Liver function tests
LVEDP	Left ventricular end diastolic pressure
LVH	Left ventricular hypertrophy
MABP	Mean arterial blood pressure
MAC	Minimum alveolar concentration
MIR	Minimum infusion rate
ODC	Oxygen dissociation curve
PAP	Pulmonary artery pressure
PCA	Patient controlled analgesia
PCWP	Pulmonary capillary wedge pressure
PEEP	Positive end expiratory pressure
PEFR	Peak expiratory flow rate
PT	Prothrombin time
PTT	Partial thromboplastin time
SaO_2	Oxygen saturation
SDD	Selective decontamination of the digestive tract
SVC	Superior vena cava
TENS	Transcutaneous electrical nerve stimulation
TIA	Transient ischemic attack
TT	Thrombin time
U+E	Urea and electrolytes
V:Q	Ventilation: perfusion
VT/F	Ventricular tachycardia/fibrillation

MONITORING

In 1986 the Department of Anesthesia at Harvard Medical School, Boston, published their standards for patient monitoring during anesthesia. The assumption was that more attentive monitoring would diminish the frequency and severity of adverse events, especially in low-risk patients, where the incidence of such events should ideally be zero. These standards applied to every patient receiving general anesthesia, regional anesthesia, or conscious intravenous medication. First and foremost was a requirement for the anesthesiologist to be present in the room throughout the conduct of such procedures. The American Society of Anesthesiologists quickly followed with national standards and in the United Kingdom the Association of Anaesthetists of Great Britain and Ireland have published similar recommendations.

Throughout this book a basic level of minimal monitoring is assumed to apply to all patients and is not repeated during the discussion of the conduct of anesthesia for each clinical topic. Monitoring is stressed when there are certain events of which to be especially aware. It is also discussed when monitoring over and above the basic minimum is recommended. The standards for basic intraoperative monitoring as approved by the ASA House of Delegates are shown below.

STANDARDS FOR BASIC INTRAOPERATIVE MONITORING

(Approved by House of Delegates on October 21, 1986, and last amended on October 23, 1990, placed in effect January 1, 1991)

These standards apply to all anesthesia care, although in emergency circumstances, appropriate life support measures take precedence. These standards may be exceeded at any time based on the judgment of the responsible anesthesiologist. They are intended to encourage high-quality patient care, but observing them cannot guarantee any specific patient outcome. They are subject to revision from time to time, as warranted by the evolution of technology and practice. This set of standards addresses only the issue of basic intraoperative monitoring, which is one component of anesthesia care. In certain rare or unusual circumstances, (1) some of these methods of monitoring may be clinically impractical and (2) appropriate use of the described methods may fail to detect untoward clinical developments. Brief interruptions of continual* monitoring may be unavoidable. Under extenuating circumstances, the responsible anesthesiologist may waive the requirements marked with a dagger (†). It is recommended that when this is done, it should be so stated (including the reasons) in a note in the patient's medical record. These standards are not intended for application to the care of obstetric patients in labor or in the conduct of pain management.

STANDARD 1

Qualified anesthesia personnel shall be present in the room throughout the conduct of all general anesthetics, regional anesthetics, and monitored anesthesia care.

OBJECTIVE

Because of the rapid changes in a patient's status during anesthesia, qualified anesthesia personnel shall be continuously present to monitor the patient and provide anesthesia care. If a direct known hazard (e.g., radiation) to the anesthesia personnel might require intermittent remote observation of the patient, some provision for monitoring the patient must be made. In the event that an emergency requires the temporary absence of the person primarily responsible for the anesthetic, the best judgment of the anesthesiologist will be exercised in comparing the emergency with the anesthetized patient's condition and in the selection of the person left responsible for the anesthetic during the temporary absence.

STANDARD II

During all anesthetics, the patient's oxygenation, ventilation, circulation, and temperature shall be continually evaluated.

OXYGENATION

OBJECTIVE

To ensure adequate oxygen concentration in the inspired gas and the blood during all anesthetics.

METHODS

1. Inspired gas: During every administration of general anesthesia using an anesthesia machine, the concentration of oxygen in the patient's breathing system shall be measured by an oxygen analyzer with a low oxygen concentration limit alarm in use.†
2. Blood oxygenation: During all anesthetics, a quantitative method of assessing oxygenation such as pulse oximetry shall be used.† Adequate illumination and exposure of the patient are necessary to assess color.†

VENTILATION

OBJECTIVE

To ensure adequate ventilation of the patient during all anesthetics.

METHODS

1. Every patient receiving general anesthesia shall have the adequacy of ventilation continually evaluated. Although qualitative clinical signs such as chest excursion, observation of the reservoir breathing bag, and auscultation of breath sounds may be adequate, quantitative monitoring of the carbon dioxide content and/or volume of expired gas is encouraged.
2. When an endotracheal tube is inserted, its correct positioning in the trachea must be verified by clinical assessment and by identification of carbon dioxide in the expired gas.† End-tidal carbon dioxide analysis, in use from the time of endotracheal tube placement, is encouraged.
3. When ventilation is controlled by a mechanical ventilator, there shall be in continuous use a device that is capable of detecting disconnection of components of the breathing system. The device must give an audible signal when its alarm threshold is exceeded.
4. During regional anesthesia and monitored anesthesia care, the adequacy of ventilation shall be evaluated, at least, by continual observation of qualitative clinical signs.

CIRCULATION

OBJECTIVE

To ensure the adequacy of the patient's circulatory function during all anesthetics.

METHODS

1. Every patient receiving anesthesia shall have the electrocardiogram continuously displayed from the beginning of anesthesia until preparing to leave the anesthetizing location.†
2. Every patient receiving anesthesia shall have arterial blood pressure and heart rate determined and evaluated at least every 5 minutes.†
3. Every patient receiving general anesthesia shall have, in addition to the above, circulatory function continually evaluated by at least one of the following: palpation of a pulse, auscultation of breath sounds, monitoring of a tracing of intra-arterial pressure, ultrasound peripheral pulse monitoring, or pulse plethysmography or oximetry.

BODY TEMPERATURE

OBJECTIVE

To aid in the maintenance of appropriate body temperature during all anesthetics.

METHODS

There shall be readily available a means to measure the patient's temperature continuously. When changes in body temperature are intended, anticipated, or suspected, the temperature shall be measured.

CONTENTS

*Topics contributed by Chris Nixon (FRCAnes), Consultant, Department of Anesthesia, Derriford Hospital, Plymouth, UK

ADRENOCORTICAL DISEASE

The adrenal cortex produces glucocorticoid, mineralocorticoid, and sex hormones (mainly testosterone). Cortisol, the principal glucocorticoid, modulates stress and inflammatory responses. It is a potent stimulator of gluconeogenesis and antagonizes insulin. Aldosterone is the principal mineralocorticoid. It causes increased sodium reabsorption and potassium and hydrogen ion loss at the distal renal tubule. Adrenal androgen production increases markedly at puberty, declining with age thereafter. Androstenedione is converted by the liver to testosterone in the male and estrogen in the female. Cortisol and androgen production are under diurnal pituitary control (adrenocorticotrophic hormone—ACTH). Aldosterone is released in response to angiotensin II, produced following renal renin release and subsequent pulmonary angiotensin I conversion.

Clinical diseases result from relative excess or lack of hormones.

Adrenocortical excess

Cushing's syndrome

This may result from steroid therapy, adrenal hyperplasia, adrenal carcinoma, or ectopic ACTH.

Cushing's disease

This is due to an ACTH secreting pituitary tumor.

Clinical features of adrenocortical excess include, moon face, thin skin, easy bruising, hypertension (60%), hirsutism, obesity with a centripetal distribution, buffalo hump, muscle weakness, diabetes (10%), osteoporosis (50%), aseptic necrosis of the hip, and pancreatitis (especially with iatrogenic Cushing's syndrome).

Problems

1. *Control of blood sugar* (insulin may be required).

2. *Hypokalemia* resulting in arrhythmias, muscle weakness, and postoperative respiratory embarrassment.

3. *Hypertension, polycythemia, congestive heart failure.* The patient may require central venous and/or pulmonary artery wedge pressure monitoring.

4. *Atrophic skin and osteoporosis* demand careful positioning and cannulation.

Adrenocortical deficiency

Acute

This may follow sepsis, pharmacological adrenal suppression or adrenal hemorrhage associated with anticoagulant therapy.

Clinical features include, apathy, hypotension, coma, and hypoglycemia.

Chronic

Chronic deficiency may follow surgical adrenalectomy, autoimmune adrenalitis (Addison's disease), adrenal infiltration with tumor, leukemia, infection (TB, histoplasmosis), amyloidosis, or be secondary to pituitary dysfunction.

Clinical features include, fatigue, weakness, weight loss, nausea, and hyperpigmentation. Hypotension, hyponatremia, hyperkalemia, eosinophilia, and occasionally hypoglycemia may also be found on further investigation.

Problems

1. *Hypotension, a low intravascular volume and a small heart may precipitate circulatory collapse with minor fluid overload.*

2. *Hypoglycemia.*

3. *Hyperkalemia*—potential risk with succinylcholine.

4. *Steroid replacement therapy.*

Hyperaldosteronism

Primary (Conn's syndrome)

This is caused by an adenoma in the zona glomerulosa secreting aldosterone.

Clinical features include, hypokalemia, muscle weakness, and hypertension.

Problems

1. *Hypokalemia may result in cardiac arrhythmias, postoperative muscle weakness, and respiratory embarrassment.*

2. *Hypertension.*

3. *Hormone replacement following adrenalectomy.*

Anesthetic management

Assessment and premedication

The state of the disease must be assessed preoperatively and electrolyte and glucose disorders corrected.

Steroid supplementation will be required for patients with Addison's disease, patients on steroid therapy and patients scheduled to undergo pituitary ablation or adrenalectomy.

Intraoperative management

No particular anesthetic technique has proved to be better than any other. Epidural anesthesia may reduce the stress response, providing the level of block is adequate and it is continued into the postoperative period. Blood volume, glucose, and potassium should be monitored.

Postoperatively

The problems described continue into the postoperative period and demand continual reassessment. Steroid replacement will be required following bilateral adrenalectomy and those on regular steroid therapy (>5 mg prednisone daily). Hydrocortisone should be administered in divided doses on a reducing scale. Pneumothorax may occur following adrenalectomy.

Further reading

Roizen MF, Stevens A, Lampe GH: Perioperative management of patients with endocrine disease. In: Nunn JF, Utting JE, Brown Jr BR, eds. *General Anaesthesia*, London: Butterworths, 1989:731-8.

Related topic of interest

Pheochromocytoma (p. 196)

AIDS AND ANESTHESIA

Acquired immunodeficiency syndrome was first reported in 1981. An exponential increase in the numbers of seropositive people infected with human immunodeficiency virus (HIV) has been seen world-wide. The virus, a retrovirus, is transmitted through sexual contact, perinatally, and via blood and blood products. Infection preferentially affects T helper lymphocytes resulting in immunosuppression and the development of "AIDS." The appearance of symptomatic immunosuppression takes a variable length of time. Opportunistic infections, malignancies, and neurological manifestations occur.

Problems

1. Patients. Seropositive patients or patients with AIDS require surgery and anesthesia for tumor excision, diagnostic biopsy and drainage of foci of infection. Such patients may also require surgery for non-related disease or trauma. Preoperative assessment should seek respiratory, neurological, gastrointestinal and hematological complications as well as the presence of secondary infection. Drug therapy may have serious side effects. The prevention of opportunistic infection requires strict adherence to aseptic techniques. The risks of sepsis from invasive monitoring should be balanced against the potential benefits. Consideration of the psychological implications of HIV infection must extend into the operating room as well as other parts of the hospital.

2. Staff. Although the virus has been isolated in many body fluids, only blood, semen, vaginal secretions, and breast milk have been implicated in transmission. It is presently considered unethical and economically unviable to test all patients for evidence of HIV infection prior to surgery. "Universal precautions," which assume that all patients may be infected are recommended. These are identical to the precautions taken with other blood borne infective agents (e.g. hepatitis B virus). Successful precautions against the transmission of the highly infective hepatitis B virus are likely to be equally effective against the less infective HIV agent. They include the use of gloves when there is any risk of contact with infective body fluids, the wearing of masks and protective glasses when infective fluids may become airborne and gowns if there is any chance of being splashed. If contact with body fluids occurs, the affected part should be washed immediately. Open or exudative wounds should be covered and contact with potentially infective fluids avoided.

Every attempt to minimize the risk of needle stick injuries should be made. Needles should not be resheathed and should immediately be disposed of in a suitable container. The risk of seroconversion following a needle stick injury is approximately 0.5%. Some centers advocate the prophylactic use of AZT if a needle stick injury from an infected patient occurs. Areas in which airway resuscitation may be required should have equipment to allow ventilation without resort to mouth-to-mouth or mouth-to-nose techniques.

3. Protection for uninfected patients. Disinfection and sterilization procedures that are routinely used are adequate to prevent HIV transmission (see Sterilization of equipment). An increasing amount of disposable equipment is being used in the care of infected patients. All blood and blood products are screened for antibodies to HIV but this does not eliminate the risk of transmission due to the "window" between infection and seroconversion as well as the possibility of clerical errors. This risk is approximately 1:60,000 per transfused unit. The risks and benefits of any transfusion should be carefully considered.

The isolation of seropositive patients is not appropriate unless the patient is bleeding or requires isolation due to immunosuppression or a contagious secondary infection.

Further reading

Association of Anaesthetists of Great Britain and Ireland. *Aids and Hepatitis B. Guidelines for Anaesthetists*. 1988.

Guidelines for prevention of transmission of HIV to health care workers. *MMWR* 1989;**38**:5-6.

Related topics of interest

Blood transfusion (p. 34)
Sterilization of equipment (p. 268)